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ENERGY GUIDE CHAIN FOR GUIDING LINES COMPRISING CHAIN LINKS WHICH CAN MOVE IN THREE DIMENSIONS

Background of the Invention

The invention relates to a guide chain for running energy lines between a stationary connection and a movable connection with movable chain links, which define each a channel section extending in the direction of the energy line guide chain.

GB 1 585 656 A1 discloses a guide chain for running lines between a stationary connection and a movable connection. The energy line guide chain is formed by pivotally connected, metallic chain links. The chain links comprise spaced-apart side walls, which are stamped from a sheet of metal and bent into shape accordingly. The spaced-apart side walls of each chain link are interconnected by a connecting plate. The connection occurs by welding, so that the chain links form a welded structure.

For a pivotal connection of adjacent chain links, the side walls comprise a circular aperture in their one end region. In the opposite end region of each side wall, an elongate slot is formed. The apertures of the one chain link are positioned with the elongate slots of the adjacent chain link such that a rivet can be passed through the elongate slot and the aperture. The rivet has a widened head with a cross section greater than the cross section of the aperture and elongate slot, respectively. To secure the rivet, a circlip is provided, which is arranged on the rivet.

The provision of the elongate slot is necessitated by the welded structure of the chain links, since elongate slots are capable of compensating

manufacturing-related inaccuracies of the welded structure.

Sub B1 The chain links of the energy line guide chain as disclosed in GB 1 585 656 A1 are adapted for pivoting about the rivets, which extend substantially crosswise to the longitudinal direction of the energy line guide chain. An energy line guide chain of this kind is not intended for lateral deflection.

A further embodiment of a conventional energy line guide chain, wherein the chain links are adapted for deflecting about axes extending crosswise to the longitudinal direction of the energy line guide chain, is disclosed in EP 0 154 882 A1. The chain links of this energy line guide chain consist of a plastic. They are formed by link plates, which are made in one piece. At one end, each link plate possesses a central joint bore. At the other end of each link plate, a central joint pin is molded to the opposite side. When the one end of a chain link is connected to the other end of an adjacent chain link, the joint pin will engage the joint bore. This permits forming a chain strand. Two chain strands are interconnected by crosspieces.

EP 0 544 051 A1 discloses an energy line guide chain, which enables an isotropic bending capability in the space, i.e. a capability of bending uniformly in the space.

Such an energy line guide chain is necessary, for example, for a multiaxial handling device, such as, for example, a robot.

This energy line guide chain is formed by an extruded tubing, whose outer circumferential wall is provided with a plurality of circumferential slots arranged in spaced relationship in the longitudinal direction of the energy line guide chain and extending

crosswise to the longitudinal direction of the energy line guide chain. These circumferential slots, which extend over the entire circumference of the tubing, are each interrupted by only one flexibly connecting crosspiece or only two flexibly acting crosspieces diametrically opposite to each other at an angular distance of 180°. The crosspieces of adjacent circumferential slots are offset relative one another by an angle at circumference of 90°. The width of the circumferential slots and their spacing between one another are dimensioned in accordance with a desired maximum bending radius of the energy line guide chain.

An energy line guide chain of this kind is problematic in that it is necessary to exchange the entire energy line guide chain, when a segment thereof is damaged, since the energy line guide chain consists of an extruded sectional tubing of plastic. This entails an increased expenditure for repair, since it is also necessary to remove from the energy line guide chain being replaced, lines and hoses extending therein, and to insert them into the new energy line guide chain.

The attachment of the energy line guide chain to a stationary connection or a movable connection occurs by chain links, which are joined to a corresponding connector. EP 0 384 153 discloses the design and construction of different end links of the chain. The chain end links comprise side plates, which are interconnected by a bottom plate. The chain end links are jointed to the adjacent chain link of the energy line guide chain. The bottom plate is screwed to a support or base plate such that the chain end link is rigidly connected to the support or base plate. A further development of a chain end link with a strain relief arrangement for an energy line guide chain is also known

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from Utility Model G 93 13 011. Likewise in the case of this chain end link, a bottom plate is provided, which is connected to a support or base plate.

Based on the foregoing, it is an object of the present invention to design and construct the known guide chain for running energy lines with spatially movable chain links, so that the energy line guide chain is repairable at relatively little cost. It is a further object of the invention to design and construct the energy line guide chain such that it is capable of receiving greater line weights. A yet further object of the invention is to describe a connecting link, which is easy to apply to a connection point, in particular a connecting link, which assists the deflection capability of the energy line guide chain.

In accordance with the invention, this object is accomplished by a guide chain for running energy lines, which comprises the characterizing features of claim 1 and claim 18, respectively. Advantageous further developments and improvements are subject matter of the respectively dependent claims.

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Contrary to the state of the art as disclosed by EP 0 544 052, the energy line guide chain of the present invention distinguishes itself in that it is constructed by individual, spatially limited, i.e., three-dimensionally movable chain links. In an extruded energy line guide chain as known from EP 0 554 051, an articulation is possible only, when the extruded sectional tubing exhibits a certain elasticity. As a result, such an energy line guide chain is capable of receiving only relatively low line weights. In the case of an energy line guide chain, as proposed by the present invention, each chain link comprises two opposite link plates extending in spaced relationship in a longitudinal

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direction of the energy line guide chain. The link plates are interconnected by at least one crosspiece. Each link plate comprises a joint body and a joint receiver, which extend substantially crosswise to the longitudinal direction of the energy line guide chain. The joint body of a link plate engages the joint receiver of an adjacent link plate. The articulated connection as is formed by the joint body and the joint receiver, does not form an integral part of the chain links, as is the case with an extruded sectional tubing of the energy line guide chain. As a result, the joint bodies and joint receivers may be designed and constructed for a greater load capacity. This applies likewise to the link plates and the crosspiece. As a result of releasably joining the chain links by the articulated connections, it will also be possible to repair the energy line guide chain, when one or more chain links have become defective.

Sub B3 In the case of the energy line guide chain as proposed by the invention, a clearance is provided respectively between the partially overlapping link plates of at least two adjacent chain links. The joint body comprises two diametrically opposite outer surface areas. Likewise, the joint bore comprises two diametrically opposite inner surface areas. Preferably, the normal lines of the outer surface areas and the inner surface areas extend substantially perpendicularly to the longitudinal direction of the energy line guide chain. When the joint body extends into the joint receiver, the outer and inner surface areas lie against each other. The outer and inner surface areas ensure a mobility of the chain links about an axis extending substantially crosswise to the longitudinal direction of the energy line guide chain. The pivoting capability of the individual chain links relative to one another is

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achieved in that only the outer and inner surface areas lie against one another. Between the further wall surface areas of the joint body and joint receiver, a clearance is provided, which allows the energy line guide chain to deflect substantially crosswise to its longitudinal axis.

According to an advantageous development of the energy line guide chain, it is proposed to make the joint body cylindrical. Preferably, the joint receiver has a substantially oval cross section. An oval cross section also means the shape of a race track. The spacing of the substantially parallel extending segments of the race track shape corresponds substantially to the diameter of the joint body, so that the joint body is rotatable about its longitudinal axis. As a result of providing the joint receiver with a substantially oval cross section, there is a play between the joint body and the joint receiver, which enables a deflection about an axis extending substantially perpendicularly to the longitudinal axis of the joint body and to the longitudinal direction of the energy line guide chain.

Instead of making the joint body cylindrical, the joint receiver as such may also have a circular cross section. In this instance, the joint body has a substantially oval cross section. The cross sectional area of the circular joint receiver is greater than the cross sectional area of the joint body. Likewise, this development of the joint connection of two adjacent chain links allows these chain links to deflect in three dimensions.

The link plates and the crosspiece are made of plastic, preferably in one piece. In this instance, the chain link has a substantially U-shaped cross section. The link plates may be designed and constructed with a

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closing strap or cover, so as to enable access to the channel of the energy line guide chain. This makes it also possible to lay lines in the channel at a later time, or to remove individual lines from the channel. Likewise, it is possible to examine individual lines in the energy line guide chain, without having to pull these out of the energy line guide chain, as is the case with an energy line guide chain disclosed in EP 0 544 051 A1.

A further, advantageous development of the energy line guide chain according to the invention proposes to adapt two adjacent chain links for a pivotal movement relative to each other at an angle of 45°.

A yet further advantageous development of the energy line guide chain according to the invention proposes to make the joint body from joint body segments separated from another by slots. In particular, the joint body comprises a radially outward directed collar in the region of its free end segment. In such a configuration of the joint body, the latter or its segments are compressed as the joint body passes through the joint receiver, so that upon completion of the passage, the joint body or the joint body segments return to their initial position, and that the collar extends around the edge of the joint receiver. The collar has a certain safety function, since it enables an improved hold of the chain links. To ensure that the collar does not assume an entraining function during an operation of the energy line guide chain, it is proposed to provide a cavity in concentric relationship with a joint receiver, into which the collar extends with a play. Preferably, the cavity is dimensioned such that the collar does not project laterally from the link plate. Should the lateral surface of the link plate slide along an object, the collar would not abrade, since it is arranged inside

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the link plate. This arrangement also reduces a possible risk of injury by a collar projecting from the link plate.

A further advantageous development of the energy line guide chain according to the invention proposes that the crosspiece comprises a convexly curved portion, which lies in a plane extending substantially crosswise to the link plate. The crosspiece further comprises an opposite portion made to correspond with the convexly curved portion. The chain links of the energy line guide chain are arranged such that the convex portion of the crosspiece of one chain link engages the corresponding opposite portion of the crosspiece of an adjacent chain link.

This configuration of the crosspiece allows to accomplish that adjacent chain links are guided while being pivoted. A guidance of the chain links is accomplished, preferably by forming the convexly curved portion in a free end region of a projection extending in the longitudinal direction of the energy line guide chain. The crosspiece comprises a cutout that merges into the region, with the cutout narrowing from an end face of the crosspiece in the direction of the concave portion. As a result of narrowing the concave portion, it is possible to limit the deflection capability of adjacent chain links. The advantageous further development of the energy line guide chain allows to accomplish likewise that the crosspieces form quasi a cover, which protects the lines laid in the energy line guide chain against external influences. In particular, it is prevented that dirt particles enter the energy line guide chain.

The chain links of the energy line guide chain are made preferably of a plastic. In particular, it is

suggested that the plastic be fiber-glass reinforced. To simplify the manufacture of the individual chain links, a further advantageous development of the energy line guide chain proposes to make at least the convex portion and the concave portion symmetrical with respect to an axis extending substantially parallel to the longitudinal axis of the energy line guide chain.

To receive greater line weights or for greater self-supporting lengths of the energy line guide chain, it is proposed that two adjacent chain links comprise two spaced-apart outer joint axes. In this instance, adjacent links comprise crosspieces, whose overall extension between the joint axes is greater than the spacing of the joint axes. This allows to prestress the energy line guide chain, thereby enabling it to receive greater line weights. The energy line guide chain with a prestress may also have a greater self-supporting length than is the case with an energy line guide chain without a prestress.

For purposes of limiting the angle of traverse of adjacent chain links and, thus, likewise for forming a predetermined radius of curvature, it is proposed that at least two adjacent chain links comprise two spaced-apart, opposite crosspieces, which extend crosswise to the longitudinal direction of the energy line guide chain. In a stretched state of the energy line guide chain, the crosspieces of adjacent chain links, which extend in a common plane, are spaced from each other. In a curved region of the energy line guide chain, these crosspieces adjoin each other.

A yet further, advantageous development of the invention proposes that the energy line guide chain comprises at least one crosspiece, which can be detachably connected with its one end to a link plate.

The other end of the crosspiece is advantageously connected to the link plate by means of a film hinge. The link plate, the film hinge, and the crosspiece may be made in one piece.

In particular, it is proposed that in the region of the film hinge, the crosspiece comprises at least one projection, so that in a closed position of the crosspiece, the projection lies on an edge of the link plate. This allows to accomplish that the film hinge is relieved, when the crosspiece has taken its closed position, and a force is exerted on the crosspiece in the direction of a channel section. In this instance, the force is absorbed by the projection, so that the film hinge is held substantially free of stress. A yet further, advantageous development proposes that the crosspiece forms a cover.

To limit the angle of traverse of adjacent link plates about an axis extending substantially crosswise to the longitudinal direction of the energy line guide chain, it is proposed that the link plate comprises at its one end a stop element and at its other end a stop surface, which is made substantially parallel to a center plane of the link plate. This configuration of the link plate accomplishes that during a lateral swing motion of adjacent link plates, the stop and stop surface prevent the chain links or link plates from locking up.

A further inventive concept proposes a guide chain for running energy lines between a stationary and a movable connection, with jointed chain links of plastic. This guide chain comprises at least one connecting link. The connecting link is designed and constructed such that it facilitates joining the connection link to a connection point or to a connection element, which is attached to the connection point. In particular, the

connecting link is designed and constructed such that it assists the deflection capability of the energy line guide chain.

The energy line guide chain of the present invention with at least one connecting link distinguishes itself in that the at least one connecting link comprises a base body with at least one receptacle for receiving a connection element mounted to a connection point, and a locking element cooperating with the base body, which is adapted for locking the connection element with a base body.

More concretely, it is proposed to limit the receptacle by a wall, which is molded to the bottom, and made at least in part spring-elastic, and that the wall forms with the connection element a snap connection. This configuration of the connecting link in combination with the connection element, which is mounted to a connection point, facilitates joining the connecting link to the connection element.

A further advantageous development of the energy line guide chain proposes to form the wall by at least two wall segments, which are separated by slots. Preferably, four wall segments form the wall, with two opposite wall segments being made substantially rigid, and the two further opposite wall segments being made substantially spring-elastic. Preferably, the substantially spring-elastic wall segments comprise corresponding recesses or projections, which form a snap connection with a correspondingly constructed connection element. The spacing of the further wall segments may be greater than the inside width of the connection element, so that only the spring-elastic wall segments produce a connection between the connecting link and the connection element.

A yet further, advantageous development of the energy line guide chain proposes to join the locking element to the base body for displacement therewith, so that the locking element impedes at least the deflection capability of the wall in a locking position, and releases it in another position. This advantageous configuration and further development of the energy line guide chain accomplish that the mounting of the connecting link to a connection element can be realized in a very simple manner and with very little force, since only the spring-elastic wall segments must be pushed apart. A locking engagement is realized by the locking element.

To realize an easy and reliable locking engagement, an advantageous development of the energy guide chain proposes to make the locking element substantially U-shaped. In this instance, the free legs of the locking element lie in the locking position at least in part against the wall, in particular against the elastic wall segments, so that the wall segments are prevented from springing apart.

It is proposed that the base body of the connecting link comprises a slide-in opening, in which the locking element is held for displacement. In the locking position, the free legs lie in part against the wall, in particular against the elastic wall segments and the lateral surfaces of the slide-in opening. This ensures that even in the case of relatively high pull-off forces, the locking engagement remains secured, since the side walls of the slide-in opening restrict the free legs of the locking element in their freedom of movement.

To ensure that a locking engagement of the connecting link with the connection element is enabled only, when the connection between the connecting link and

the connection element is properly established, a yet further, advantageous development of the energy line guide chain proposes that the locking element comprises a safety flap, which is spaced from the legs and made substantially parallel to same. In this instance, the locking element can be moved to its locking position only, when the connection element releases the safety flap.

To this end, it is proposed in an advantageous manner to provide the base body with a projection, which extends into the plane of movement of the safety flap. The safety flap comprises an opening, which the projection engages in the locking position. The safety flap can then be deflected by the connection element such that same can be brought to the locking position.

To prevent an automatic release of the locking engagement, it is proposed that the projection and the opening are adapted to each other in their shape, so that a movement of the safety flap is prevented.

A yet further, advantageous development of the energy line guide chain proposes that the receptacle extends fully through the base body. In particular, it is proposed to make the receptacle and connection element rotationally symmetric, thereby allowing the connecting link to perform a swing motion.

Brief Description of the Drawings

In the following, further details and advantages of the energy line guide chain according to the invention are described in greater detail with reference to embodiments shown in the drawing, in which:

Figure 1 is a fully sectioned front view of a first embodiment of a chain link;

Figure 2 is a bottom view of a chain link of Figure 1;

Figure 3 is a top view of the chain link of Figure 1;

Figure 4 is a top view of a segment of an energy line guide chain with chain links of Figure 1;

Figure 5 is a fully sectioned front view of a segment of an energy line guide chain with chain links of Figure 1;

Figure 6 is a front view, enlarged, of a joint connection between adjacent chain links;

1B4 Figure 7 is a sectional top view of a joint connection of Figure 6;

Figure 8 is a bottom view of a further embodiment of a chain link;

Figure 9 is a fully sectioned front view of the chain link of Figure 8;

Figure 10 is a top view of the chain link of Figure 8;

Figure 11 is a top view of a segment of an energy line guide chain with chain links of Figure 8;

Figure 12 is a fully sectioned front view of the energy line guide chain of Figure 11;

Figure 13 is a front view of a further embodiment of a chain link;

Figure 14 is a side view from the right of the chain link of Figure 13;

Figure 15 is a cross sectional view of the chain link of Figure 13;

Figure 16 is a cross sectional view of the chain link of Figure 13 with a closed crosspiece;

Figure 17 is a longitudinal sectional view of the chain link of Figure 13;

Figure 18 is a front view of the basic form of a connecting link;

Figure 19 is a sectional view of the connecting link along line A-A of Figure 18;

Figure 20 is a sectional view of the connecting link along line B-B of Figure 19.

Figure 21 is a sectional view of the connecting link of Figure 18 along line C-C of Figure 19;

Figure 22 is front view of a locking element for a connecting link of Figure 18;

Figure 23 is a top view of the locking element;

Figure 24 is a bottom view of the locking element;

Figure 25 is a sectional view of the locking element along line C-C of Figure 22;

Figure 26 is a sectional view of the locking element along line A-A of Figure 24;

Figure 27 is a sectional view of the locking element along line B-B;

Figure 28 is a sectional view of the connecting link of Figure 18 with a locking element of Figure 22 in an assembled position;

Figure 29 is a sectional view of the connecting link with the locking element of Figure 28 along line A-A of Figure 28;

Figure 30 is a sectional view of the connecting link with the locking element along line B-B of Figure 28;

Figure 31 is a sectional view of the connecting link with the locking element and with a deflected safety flap;

Figure 32 shows the connecting link with the locking element in an end position of the locking element;

Figure 33 is a sectional view of the connecting link with the locking element along line A-A of Figure 32; and

Figure 34 is a sectional view of the connecting link with the locking element along line B-B of Figure 32.

Detailed Description of the Preferred Embodiments

Figures 1-3 illustrate a first embodiment of a chain link **1** for a guide chain for running energy lines. The chain link **1** comprises two link plates **2**, **3** facing each other in spaced relationship and extending in a longitudinal direction of the energy line guide chain.

Each link plate **2**, **3** comprises a joint body **6** and a joint receiver **7**. The joint body **6** is formed on an outer side of link plates **2** and **3**, respectively. The joint body **6** and the joint receiver **7** extend substantially crosswise to the longitudinal direction of the energy line guide chain. The joint body **6** and the joint receiver **7** are designed and constructed in spaced relationship with each other, when viewed in the longitudinal direction of the chain link.

Crosspieces **4** and **5** interconnect the link plates **2**, **3**. The crosspieces **4**, **5** are designed and constructed in spaced relationship with each other. Both the crosspieces **4**, **5** and the link plates **2**, **3** define a channel section **8** for arranging the lines. Each crosspiece **4**, **5** is substantially aligned with a longitudinal edge of link plate **2** or **3**.

The crosspiece **4** comprises a convexly curved portion **9**, which extends in a plane extending substantially crosswise to each link plate **2** or **3**. The crosspiece **4** includes a portion **10**, which is designed and constructed to correspond with the convexly curved portion **9**. The portion **10** is opposite to the portion **9**. The portion **9** and the portion **10** are symmetric with

respect to an axis **11** extending substantially parallel to the longitudinal axis of the energy line guide chain.

Figures 4 and 5 show a first embodiment of an energy line guide chain **12** of the present invention. The energy line guide **12** is formed by chain links **1**. The design and construction of each chain link **1** corresponds to that of the chain link shown in Figures 1-3.

The chain links **1** are interconnected by joints. The joint connection occurs by means of joint bodies **6**, which engage joint receivers **7**. Adjacent chain links **1** are adapted for pivoting about a joint axis **13** extending substantially perpendicularly to a longitudinal axis **14**. As can be noted from Figure 4, the portion **10** of crosspiece **4** lies against the convexly curved portion **9** of the crosspiece **4** of an adjacent chain link. The crosspieces **4** are designed and constructed such that, when viewed in the longitudinal direction of the energy line guide chain **12**, same have an extension, which is greater than the spacing between two outer joint axes **13** of two chain links, thereby imparting to the energy line guide chain a prestress.

As shown in Figure 5, the crosspieces **5** of adjacent chain links are adapted for coming into contact with their respective end faces, so that the crosspieces **5** define the radius of curvature of the energy line guide chain.

The joint connection of adjacent chain links occurs by means of joint bodies **6** and joint receivers **7**. The joint connection of adjacent chain links is shown enlarged in Figures 6 and 7.

Sub B5 Each joint body **6** is made substantially cylindrical. The joint receiver **7** has a substantially oval cross section. The joint body **6** and joint receiver **7** comprise each surface sections, which form a common

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connection area **16**. The connection area **16** extends substantially in the longitudinal direction of the link plates **3**. Between the diametrically opposite connection areas **16**, a gap **17** is formed between an outer surface area **18** of joint receiver **7** and an inner surface area **19**. The joint connection comprises two substantially diametrically opposite gaps **17**, which are crescent-shaped in the illustrated embodiment. When viewed in the circumferential direction of joint body **6**, the gaps extend from the connection area **16** to the connection area **16** on the opposite side.

The gap **17** between joint body **6** and joint receiver **7** allows adjacent chain links to pivot. The chain links are adapted for pivoting about a pivot axis **15**, which is substantially perpendicular to the joint axis **13**.

Between the overlapping regions of link plates **2**, **3** of adjacent chain links, a clearance **20** is formed, which allows adjacent chain links to pivot about pivot axis **15**. While pivoting about pivot axis **15**, the surfaces of both the convexly curved portion **9** and the correspondingly constructed portion **10** slide along each other.

Each chain link **1** of energy line guide chain **12** is capable of deflecting about a joint axis **13** and a pivot axis **15**, so that adjacent chain links of an energy line guide chain can be deflected with a spatial limitation, i.e. in a three-dimensional space. The energy line guide chain **12** may be designed and constructed with such configured chain links **1** in full or in sections.

1 B6 Figures 8 and 9 show a second embodiment of a chain link **21**. The chain link **21** comprises two spaced-apart, opposite link plates **22**, **23**, which extend in a

longitudinal direction of an energy line guide chain. Each link plate **22**, **23** comprises a joint body **26** and a joint receiver **27**. The joint body **26** and joint receiver **27** extend substantially crosswise to the longitudinal direction of an energy line guide chain. The joint body **26** and joint receiver **27** of the link plates **22**, **23** are designed and constructed such that they engage each other, when the chain links **21** are joined.

Each link plate **22**, **23** is interconnected by two crosspieces **24**, **25**. The crosspieces **24**, **25** are substantially aligned with a longitudinal edge of link plates **22** and **23**, respectively. The link plates **22**, **23** and crosspieces **24**, **25** define a channel section **28**.

The crosspiece **24** comprises an extension **32** extending in the longitudinal direction of the energy line guide chain. The extension **32** comprises a substantially convexly curved portion **29**. The extension **32** and the convexly curved portion **29** are made substantially symmetric with respect to an axis **31**. The axis **31** extends substantially parallel to the longitudinal axis of the energy line guide chain.

The crosspiece **24** comprises a concavely curved portion **30**, which is formed opposite to the convexly curved portion **29**. The portion **30** is made to correspond with portion **29**. It is formed in a cutout **33**. The cutout **33** extends from an end face **34** inward into the crosspiece **24** and in the direction of axis **31**. The cutout **33** narrows from end face **34** in the direction of concave portion **30**.

Figures 11 and 12 show a segment of an energy line guide chain **35**, which is assembled from chain links **21**. Adjacent chain links **21** are each capable of deflecting about a joint axis **36**. The joint axis **36** is formed by pairing joint body **26** and joint receiver **27**.

As best seen in Figure 11, the extension **32** engages with its convexly curved portion **29** the cutout **33** with its concavely curved portion **30**. Both the crosspieces **24** and the extensions **32** and cutouts **33** are designed and constructed such that the energy line guide chain **35** is prestressed, which is not absolutely mandatory.

The radius of curvature is limited by the stops formed by crosspieces **25**.

Sub B1 ~~Both the joint body **26** and the joint receiver **27** of the chain links are designed and constructed in the same way as those of chain link **21**. For this reason, the description with reference to Figures 6 and 7 is herewith incorporated by reference.~~

Figures 13 to 17 illustrate a further embodiment of a chain link **37** of plastic for a guide chain for running energy lines. The chain link **37** is made in one piece of a plastic, in particular by the injection molding method.

The chain link **37** comprises two opposite link plates **38**, **39** extending in spaced relationship in a longitudinal direction of the energy line guide chain. The link plates are interconnected by a crosspiece **41**. Together with the crosspiece **41**, they form a U-shaped basic form of the chain link **37**. As best seen in Figure 17, the crosspiece **41** extends to the overlapping regions of the link plates, so that it forms a cover.

Each link plate **38**, **39** comprises a joint body **42** and a joint receiver **46**.

The joint body **42** is made integral with an outer side of link plates **38** and **39** respectively, as shown in Figure 14. The joint body **42** is formed by joint body segments **43**, which are separated by slots **44**. On its free end portion, the joint body **42** comprises a radially outward directed collar **45**. Likewise, the

collar **45** is subdivided by slots **44**. In the illustrated embodiment, three slots **44** are provided, each 120° out of phase.

sub B8 The joint bodies **42** are provided in end regions of link plates **38**, **39**. The opposite end regions of link plates **38**, **39** accommodate the joint receivers **46**. The joint receivers **46** have a substantially elliptic cross section, so that the joint bodies are capable of pivoting in the corresponding joint receivers such as to deflect adjacent chain links **37** relative to each other in the lateral direction.

The joint receiver **46** comprises a circumferential cavity **47**. This cavity is made substantially coaxial with the joint receiver **46**. The depth of the joint receiver corresponds substantially to the thickness of collar **45**.

A crosspiece **40** is flexibly hinged to the link plate **39**, and can be detachably connected with its other end to the link plate **38**. The connection of crosspiece **40** to link plate **39** is formed by a film hinge **48**. The film hinge **48**, link plate **39**, and crosspiece **40** are made in one piece.

The film hinge **48** is formed in an edge portion of link plate **39**. On both sides of the film hinge **48**, clearances **52** are provided, as shown in Figure 17. The film hinge is formed by a film bridge **49**, which connects with its one end to link plate **39**, and with its other end to crosspiece **40**. The thickness of film bridge **49** is smaller than the thickness of link plate **39**. To form the film bridge **49**, the edge region of link plate **39** contains recesses **50**, **51** extending in the transverse and in the longitudinal direction of link plate **39**, as shown in Figure 15.

In the region of film hinge **48**, the crosspiece **40** comprises a projection **53** extending crosswise to the longitudinal direction of the crosspiece. In the closed state of chain link **37**, the projection **53** lies on an edge **54** of recess **50**, as shown in Figure 16. This relieves the film hinge **48** and, thus, film bridge **49**, when a force is exerted on the crosspiece **40** and in the direction of crosspiece **41**.

The end region of crosspiece **40** opposite to film hinge **48** is provided with a locking element **55**. The locking element **55** is formed by a hook **56**. The hook **56** cooperates with a counterhook **57**, which is formed in a recessed portion of the end region of link plate **38**. In spaced relationship with hook **56**, a ridge **58** is provided, which defines together with the hook **56** a space **59** for engaging counterhook **57**. With its one surface, the ridge **58** lies against the inner surface of link plate **38**, as shown in Figure 16. The ridge **58** makes it possible to reduce at least, if not avoid altogether, a mobility and, thus, a stress on film hinge **48**, since the crosspiece **40** is prevented from moving in its longitudinal direction.

The link plates **38**, **39** and crosspieces **40**, **41** define a channel section **60** for laying lines, in particular electrical lines.

sub B9 To limit the angle of traverse of adjacent chain links about an axis extending crosswise to the longitudinal direction of the energy line guide chain, preferably each link plate comprises at its end a stop element **61**. The opposite end of the link plate is provided with stop surfaces **62**. The stop elements **61** cooperate with the stop surfaces **62** of an adjacent chaint link. The stop surfaces **62** are formed in a plane extending substantially parallel to a center plane of the link plate. Preferably, the stop surfaces are made

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equidistant from the center plane. Likewise, the stop element **61** is formed in the region of the center plane of the link plate.

To secure an energy line guide chain to a stationary and/or mobile connection, the energy line guide chain comprises connecting links.

Figures 18-21 illustrate the configuration of a preferred embodiment of a connecting link **63**. The connecting link **63** is formed by a base body **64**. The base body **64** connects to two link plates **65**. The link plates **65** are arranged in spaced and in facing relationship. Each link plate **65** comprises a joint receiver **66**. On the external side faces of the link plates **65**, the joint receiver **66** comprises cavities **67**.

The configuration of the joint receivers **66** corresponds to that of the joint receivers of the above-described chain links, so that the connecting link **63** can be joined to corresponding joint bodies. This is not mandatory. Depending on which end of an energy line guide chain is intended to receive the connecting link, the connecting link may also be provided with corresponding joint bodies, which are adapted for engaging corresponding joint receivers.

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The base body **63** is provided with a receptacle **68**, which is adapted for accommodating a connection element not shown. The connection element is attached to a connection point. In the illustrated embodiment, the receptacle **68** is designed and constructed crosswise to the longitudinal axis of an energy line guide chain, which is not absolutely mandatory. The joint receiver may also be made parallel to the longitudinal axis of an energy line guide chain. It may even intersect the longitudinal axis of the energy line guide chain at an angle.

The receptacle **68** is bounded by a wall **69**. The wall **69** extends from a bottom wall **70** to a cover wall **79**. The wall **69** is made integral with the bottom wall **70**. The wall **69** is formed by wall segments **71**, **73**. In the illustrated embodiment, four wall segments are provided. The wall segments are separated from one another by slots **72**, as shown in Figure 21. The opposite wall segments **71** are made spring-elastic, so that same form a snap connection with the connection element not shown. The wall segments **73** are made substantially rigid.

Inside the base body **64**, a slide-in opening **74** is provided. This slide-in opening extends substantially crosswise to the longitudinal direction of receptacle **68**. The slide-in opening is defined by bottom wall **70**, cover wall **79**, and side walls **77**. In the region of an inlet opening **90** in slide-in opening **74**, the side walls **77** are provided with projections **78**. The projections **78** are directed toward each other. The inside width of the inlet opening **90** is smaller than the inside spacing between the side walls **77**, so that in the region of transition between the projection **78** and the side wall **77**, a stop surface **89** is formed, as can be noted from Figure 21.

The receptacle **68** extends through the bottom wall **70**. Adjacent receptacle **68** is a projection **88**. This projection **88** extends away from the bottom wall **70** of base body **64**.

Below the bottom wall **70**, a slide-in pocket **75** is provided. The slide-in pocket **75** is defined by bottom wall **70** and a transverse member **76**. The transverse member **76** extends only over a portion of bottom wall **70**, so that the receptacle **68** is unblocked.

Figures 22-27 illustrate a locking element **80**. The locking element **80** cooperates with the base body **64**

of connecting link **63**, as will be described in greater detail further below.

The locking element **80** is substantially U-shaped. It comprises two legs **81**, **82**, which are interconnected by a common base **83**. The free legs **81**, **82** are made spring-elastic. On its outer surface, each leg **81**, **82** comprises a stop **84**, which is formed by a surface extending substantially parallel to the base **83**. The spacing between internal side surfaces of the legs **81**, **82** corresponds substantially to the outside width of wall **69**.

A safety flap **85** is provided in spaced relationship with the free legs **81**, **82** and substantially parallel to same. The flap **85** comprises an opening **86**, which is provided in the region of a free end face **87**.

The locking element **80** is designed and constructed such that the free legs **81**, **82** can be inserted into the slide-in opening **74**. The safety flap **85** is adapted for engaging the slide-in pocket **75** of base body **64**.

Figures 28-31 illustrate the connecting link with the locking element **80** in an assembled state. The free legs **81**, **82** are inserted into the slide-in opening. Same do not contact the outer surface of wall segments **71**, so that the wall segments **71** are capable of deflecting radially outward. On their inner surfaces **92**, the wall segments **71** may comprise cavities and/or projections, which cooperate with correspondingly shaped projections or cavities of a connection element not shown, which can be inserted into the receptacle **68**.

As can be noted from Figure 28 and from Figure 30, the end face **87** of safety flap **85** lies against projection **88**. The projection **88** limits the path of

displacement of locking element **80** crosswise to the receptacle **68**.

The locking element **80** is undetachably connected to base body **64**. To this end, stop surfaces **84, 89** are provided. The surfaces **84, 89** limit the mobility of locking element **80**, so that the latter cannot be removed from slide-in opening **74** without compressing the free legs **81, 82**.

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~~When the connecting link **63** is connected to a connection element not shown, the connection element will engage opening **68**. To prevent the connecting link **63** from disengaging from the connection element, a snap-in engagement occurs between the walls **71** and the connection element. To block this snap-in engagement, the locking element **80** is further pushed into slide-in opening **74**, until it occupies the end position shown in Figures 32-34. To realize that the locking element **80** is further pushed in inside the slide-in opening **74**, the locking element **80** pushes the safety flap away from the base body **64**, as shown in Figure 31. The safety flap **85** is pushed away from base body **64** so far that it is possible to slide the safety flap **85** over the projection **88**. At the same time, this movement causes the free legs **81, 82** to slide between the side walls **77** and the outer surfaces **92** of wall segments **71**, so that the free legs **81, 82** lie both against the side wall **77** and against the outer surface **92** of wall segments **71**, for purposes of preventing the wall segments **71** from moving radially outward. Figure 33 illustrates the position of legs **81, 82**, in which the locking engagement is reached.~~

Figure 34 illustrates the position of safety flap **85**, which same will occupy, when the locking position is reached. In this position, the projection **88** engages opening **86**. Likewise in this position, an end

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portion of the connection element may extend through the receptacle **68** right into the opening **86**.

The projection **88**, which extends at least in part into the opening **86**, ensures that the locking engagement will not be released unintentionally. To disengage, it will be necessary to move the safety flap away from the base body **64**, so that the projection **88** no longer engages opening **86**, thereby allowing the locking element **80** to slide from its locking position to an assembled position.

Preferably, the receptacle **68** is made rotationally symmetric. A correspondingly configured, rotationally symmetric connection element engages same. As a result, a rotatability of the connecting link **63** about the longitudinal axis of the receptacle is achieved, thereby enabling an improved deflection capability of an energy line guide chain toward the side.

NOMENCLATURE

1	Chain link
2,3	Link plate
4,5	Crosspiece
6	Joint body
7	Joint receiver
8	Channel section
9	Convex portion
10	Corresponding portion
11	Axis
12	Energy line guide chain
13	Joint axis
14	Longitudinal axis
15	Pivot axis
16	Connection area
17	Gap
18	Outer surface area
19	Inner surface area
20	Clearance
21	Chain link
22,23	Link plate
24,25	Crosspiece
26	Joint body
27	Joint receiver
28	Channel section
29	Convex portion
30	Concave portion
31	Axis
32	Extension
33	Cutout
34	End face
35	Energy line guide chain
36	Joint axis

37	Chain link
38	Link plate
39	Link plate
40	Crosspiece
41	Crosspiece
42	Joint body
43	Joint body segments
44	Slot
45	Collar
46	Joint receiver
47	Cavity
48	Film hinge
49	Film bridge
50	Recess
51	Clearance
52	Gap
53	Projection
54	Edge
55	Locking element
56	Hook
57	Counterhook
58	Ridge
59	Space
60	Channel section
61	Stop element
62	Stop surface
63	Connecting link
64	Base body
65	Plate
66	Joint receiver
67	Cavity
68	Receptacle
69	Wall
70	Bottom wall

71	Wall segment
72	Slot
73	Wall segment
74	Slide-in opening
75	Slide-in pocket
76	Transverse member
77	Side wall
78	Projection
79	Cover wall
80	Locking element
81	Leg
82	Leg
83	Base
84	Stop
85	Safety flap
86	Opening
87	End face
88	Projection
89	Stop surface
90	Inlet opening
91	Outer surface
92	Inner surface